Digital competencies: perceptions of primary school teachers pursuing master's degrees from eight African countries

Andresa Sartor Harada (iD)
Universidad Internacional de Valencia (VIU), Valencia, Spain and Department of Teacher Training, Faculty of Education, Universidade Internacional do Cuanza, Kuito, Angola
dreharada@gmail.com
Juliana Azevedo Gomes (iD)
Universidad Internacional de Valencia (VIU), Valencia, Spain and Department of Teacher Training, Faculty of Education, Universidad Internacional Iberoamericana, Campeche, Mexico
Oscar Ulloa Guerra (iD)
Department of Teacher Training, Faculty of Education, Universidade Internacional do Cuanza, Kuito, Angola
Roberto Ruiz (iD) **and Rubén Calderón** (iD)
Faculty of Social Sciences, Universidad Europea del Atlántico, Santander, Spain

The United Nations Educational, Scientific, and Cultural Organization (UNESCO) highlights the relevance of using information and communications technology (ICT) in education for improving the quality of education. To achieve this goal, it is necessary to extend research on digital competences in education. To advance the development of digital competencies it is necessary to take account of how teachers perceive these. In addition, systematic reviews of the literature on ICT and education show an imbalance regarding the amount of research from Africa compared to other regions of the world. In this sense, the objective of this study carried out between March 2019 and April 2020 was to analyse the perceptions of primary school teachers from 8 African countries about their digital competences. The teachers were master's students in teacher training on virtual platforms. A mixed methodological perspective (quantitative-qualitative) was adopted and a questionnaire with closed and open-ended questions was applied. The quantitative and qualitative analyses show that the teachers recognised their digital competence at all 3 levels. The needs highlighted by teachers were in developing their knowledge of how to create content with the support of technology. However, the available resources, which differed in the participants' work contexts and did not enable the equal use of ICT in all African countries, was an important issue highlighted by the participants. It is recommended that teacher training in digital competence is prepared using instructional design that promotes innovation and contact with real teaching-learning situations.

Keywords: African continent; digital competence; educational needs; primary education; primary school teachers' perspectives

Introduction
The effective use of technology in the classroom encourages pedagogical transformation while strengthening the students' competence (Azinian, 2009; Hakkarainen, Ilomäki, Lipponen, Muukkonen, Rahikainen, Tuominen, Lakkala & Lehtinen, 2000; Morales, Trujillo & Raso, 2015). To guarantee the quality of learning in this context, and equity in education, it is necessary to develop teacher's integrated professional ICT skills for them to be able to implement ICT to enable their students to acquire the fundamental skills necessary for the knowledge society (Jung, 2005; Tejada Fernández, 2009).

Several authors highlight the need to extend the studies of ICT and education on the African continent (Karatepe & Akay, 2020; Moodley, Callaghan, Fraser & Graham, 2020). Systematic reviews of the literature on ICT and education show an important imbalance in relation to the amount of research from Africa compared to other regions of the world (Esteve-Mon, Llopis-Nebot & Adell-Segura, 2020; Fernández-Batanero, Montenegro-Rueda, Fernández-Cerero & García-Martínez, 2022; Sartor-Harada, 2018).

UNESCO (2019) established the *ICT Competency Framework for Teachers* as a tool to drive the initial formation and continued education of teachers in the use of ICT. This framework covers a wide range of ICT skills that teachers need to apply in their professional practice to improve their work and their students' academic performance.

Teachers in training must develop tools that exceed their academic expectations and enable pedagogical successes in their classrooms (Buckworth, 2017). Teachers must transform educational paradigms to respond to the real learning needs of today's students and develop teaching skills that enable them to develop their students' competences (Rusznyak, 2018). This is the greatest challenge for teachers at all stages of education (Betancourt-Odio, Sartor-Harada, Ulloa-Guerra & Azevedo-Gomes, 2021).

However, is it possible to advance in the development of digital competence without taking teachers' perceptions thereof into account? If we view the way in which we perceive reality, an important factor in behaviour (González Rey, 1997), then perceptual processes are central to understanding how teachers self-manage the development of their digital competence (Asenjo Gómez & Asenjo Gómez, 2021; Robles Amavizca & Ángulo Armienta, 2018; Usher & Pajares, 2008). Teachers' perceptions of their digital competence condition their

attitudes and decisions regarding the need to make progress in the integration of ICT in education (Betancourt-Odio et al., 2021; Garzón-Artacho, Sola-Martínez, Romero-Rodríguez & Gómez-García, 2021).

Three main elements were covered in this research: the centrality of ICT in the current parameters for quality education, the need to create contextualised methodology for the development of teachers' digital competence and the need to expand studies on the self-perception of the digital competence of teachers in African countries. The convergence of these three elements in a contextualised way in the field of graduate programmes underpins the research problem of our current study, namely: how do primary school teachers from African countries pursuing postgraduate studies in virtual platforms developed by institutions linked to the Ibero-American University Foundation (FUNIBER) perceive their digital competences?

Consequently, the aim of the study was to analyse the perceptions of primary school teachers from African countries (pursuing postgraduate studies in virtual platforms of institutions linked to FUNIBER) about their digital competence. The findings of this research are considered relevant for the creation of a specific methodology that facilitates the acquisition and application of digital competence in school settings, especially in areas of curriculum and assessment, pedagogy and the application of digital skills (Núñez, Gaviria-Serrano, Tobón, Guzmán-Calderón & Herrera, 2019; Serafín Diel & Bueno Pérez, 2019).

Literature Review
Esteve-Mon et al. (2020) define competence in the framework of digital competence as the deep understanding and development of skills and attitudes in the digital world for the development of professional action. From the six categories proposed by the UNESCO (Understanding ICT in education, curriculum and assessment, pedagogy, ICT-application of digital competences, organization and administration, and teachers' professional learning), we have selected three that best capture the dynamics of the teacher in the classroom: curriculum and assessment, pedagogy and application of digital competences (UNESCO, 2019). This choice is justified by the fact that these standards are the ones most closely related to a teacher's classroom practice.

Curriculum and assessment
According to Pariente Alonso (2005), the integration of ICT in curriculum development and educational assessment requires that we take three different dimensions into account: the first is related to the skills and abilities that students and teachers must possess for their use of technology; the second is the perception of the powerful resource the teacher wields to foster knowledge construction processes in their students; and the third is a methodology for change based on the impact on the manner of accessing knowledge, exchanging information and carrying out teaching and learning processes.

Coll (2008) reinforces the need for curricular reorganisation and an approach to evaluating the integration of ICT given that the incorporation of technology into the educational scenario must respond to a set of new needs brought about by the knowledge society.

In this sense, the inclusion of ICT to promote the objectives defined in the curriculum and improve assessment is a response to an improvement in the teachers' work and the demands of the new society (Du Plessis, 2020). As Cacheiro González (2018) states, technology must be sufficiently incorporated to form a transversal area in the curriculum, promoting a shift from theory to practice based on an awareness stemming from teachers, the main stakeholders, creating opportunities to learn about the available technology, practice its operational use, and analyse the advantages and disadvantages thereof in various teaching and learning scenarios to enhance academic freedom and liberty.

In this case, teachers are responsible for seeking appropriate support from technology when applying curriculum and assessment reforms. Their ICT knowledge and skills enable them to improve the quality of their own follow-up and mentoring processes, and to offer specific help within educational assessment (Coll & Monereo, 2008). Hence the need to reinterpret the curriculum for effective decision-making and the implementation of authentic assessment strategies in response to the advances of the knowledge society.

Pedagogy
Pedagogy has been transformed by the use of ICT. At first, teachers used technological tools to optimise their pre-class work (for the preparation of exercises, elaboration of multimedia presentations, electronic mail (email) communication with students and other teachers on the team, etc.) and, little by little, technology has gained space to support pedagogy in the classroom (Area Moreira, 2008). However, the role of ICT in this educational transformation must go beyond supporting pre-established pedagogical practice; it requires creating and recreating teaching modes and experiences (Coll, Onrubia & Mauri, 2007:381):

> [...] it is precisely in this re-creation and redefinition where the potentiality of technological tools as psychological instruments either does or does not becomes effective in its contribution in establishing certain forms of organization for joint activity and influencing the intra and intermental processes involved in teaching and learning to a greater or lesser extent.

There is a need to modify pedagogy and to re-train teachers from previous generations to address the modern day students' learning needs. The generational gap requires the development of digital competences and older teachers' adoption of new social skills related to the use of ICTs and to the new ways of learning presented by today's changing society (Fernández-Cruz & Fernández-Diaz, 2016).

According to Pozo (2017:7) "it is not the same being a native in technology as it is to be an immigrant in it." This illustrates the need for a change in the mentality required by the application of ICT in the classroom, taking into account that the users we are dealing with master the native levels of their use. The transformation of pedagogy must involve the integration of technology into cutting-edge teaching methods, and the adoption of alternative, student-centred collaborative and cooperative methodologies (UNESCO, 2019).

Over the last decade, many studies have addressed the need to develop teaching digital competence in teacher training (Aguaded & Cabero, 2013; Domínguez, Bárcenas, Ruiz-Velasco & Tolosa, 2014; Sartor-Harada, 2018; Suárez Rodríguez, Almerich, Gargallo Lópe & Aliaga, 2013; Tejada Fernández & Pozos Pérez, 2018), and while these studies have taken into account factors such as personal, institutional, and contextual ones, they all highlight the need for teacher training to be developed to address the demands of the knowledge society. Current pedagogy requires new literacy involving the adoption, adaptation, and innovation of a teacher's professional development, resulting in the optimisation of the acquisition of digital competence through formal and informal learning (Carrera & Coiduras, 2012; Suárez Rodríguez et al., 2013; Tejada Fernández & Pozos Pérez, 2018).

Teachers' perceptions about their digital competences

Many studies of teachers' perceptions of their digital competence demonstrate that this is an important issue (Betancourt-Odio et al., 2021; Garzón-Artacho et al., 2021). On this subject, Jiménez, Miguel, Fernández and Díaz (2017) analysed the self-perception of their digital competence of a sample of teachers taking a diploma course at the Central University of Venezuela. The participating teachers perceived themselves as competent in uploading files and images, sending/receiving emails and accessing bibliographic databases. However, they acknowledged difficulties in participating in virtual platforms and forums.

Robles Amavizca and Ángulo Armienta (2018) illustrate how teachers in cities in the south of Mexico perceived their digital competence. Their research shows that teachers recognised that they had difficulties in developing their digital competence efficiently, although they considered themselves being prepared to integrate ICT in the planning of learning environments and experiences.

Both studies and others conducted in various countries show similar results: a significant proportion of teachers recognised their limitations in the development of digital competence (Betancourt-Odio et al., 2021; Hall, Atkins & Fraser, 2014; Quiñonez Pech, 2020). This is confirmed by more recent research in which teachers' perceptions of their digital competence in the face of forced changes brought about by the Coronavirus disease (COVID-19) in relation to the delivery and organisation of teaching. In their research with teachers in Andalusia, Spain, Garzón-Artacho et al. (2021) conclude that teachers perceived their digital competence to be at a low level, especially in terms of the creation of content, information literacy and problem-solving.

In contrast, a study by Perifanou, Economides and Tzafilkou (2021) on Greek teachers' perceptions of their digital competence in the face of the pandemic confirmed an efficient use of digital competence. Teachers perceived themselves as competent in finding, evaluating and developing resources for teaching, but having difficulty in other activities such as providing feedback related to final evaluations.

Research by Asenjo Gómez and Asenjo Gómez (2021) on teachers' self-perception of digital competence and its variations after confinement, compared European teachers' self-perception of their digital competence at two points in time, taking into account the results of an international study in 2019 and recent data from a European Commission report. The results of the study show that while 39% of teachers in the European Union considered themselves to have good or very good levels of ICT skills in 2018, more than 88% reported the need for more digital training during the pandemic.

This research literature on teachers' perceptions of their digital competence highlights the importance of this type of study for designing training policies.

Methodology
Paradigms and Methodological Design
A mixed methodological research design (quantitative-qualitative) was adopted to investigate the perceptions of primary school teachers from eight selected African countries on their digital competence in three main areas (cf. Figure 1). In the methodology, we assumed the principles of the pragmatic paradigm (Kaushik & Walsh, 2019) and use to describe the structure and characteristics of an object, situation, fact or phenomenon (Mateo, 2004).
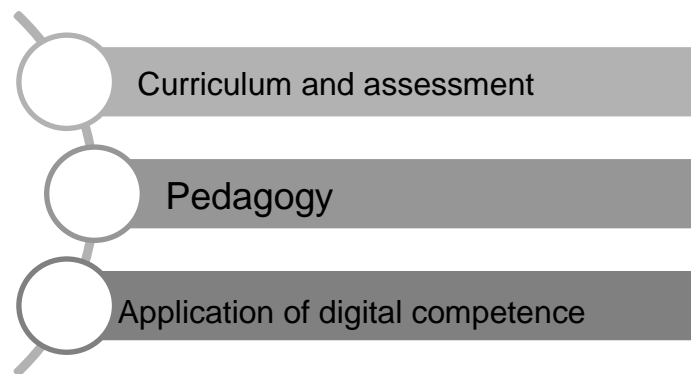
Figure 1 Areas of competence described in the ICT teaching competence framework (UNESCO, 2019)

Study Population
The participants in the study were drawn from 492 primary school teachers from several African countries pursuing postgraduate studies in virtual platforms of institutions linked to FUNIBER.

Sample Selection
Non-probabilistic sampling was applied. The selection techniques used were accessibility and purposive, considering the possibility of contact with teachers from several African countries.

Participants in the study were required to meet the following criteria:
- active teachers in primary education in Africa
- masters' students in teacher training in virtual platforms of FUNIBER (the authors are professors of a masters' in teacher training at FUNIBER).

Three hundred and seventeen teachers enrolled for the master's degree in teacher training were identified. However, to analyse the degree of perception, it was necessary to ensure that the teachers had knowledge and experience on the topic of digital competence. For this reason, a questionnaire on teaching practice and the attitudes of teachers towards innovation was applied (CUPAIN) (Santos Rego, Jover Olmeda, Naval, Álvarez Castillo, Vázquez Verdera & Sotelino Losada, 2017). Although the CUPAIN questionnaire was designed to be used by university teachers, it was considered useful as a measurement tool to determine the level of agreement and importance afforded digital competence as well as the probability and frequency of use of these competences within their teaching function.

The CUPAIN questionnaire was adapted cross-culturally, ensuring its linguistic, semantic, and cultural equivalence. Nine questions in two dimensions – teaching practice in ICT and innovative teaching practice – were selected for this version of the questionnaire. Validation of the adaptation of the instrument was carried out by five bilingual experts (Spanish/Portuguese) from the area of education and technology with mastery of the theoretical aspects of the instrument.

Teachers with a score equal to or less than 50% on the never/few times scale in both dimensions were excluded from the study. Teachers who did not use technology in their teaching practice sometimes did not meet the conditions for analysis of their digital competence.

The application of the CUPAIN questionnaire reduced the number of participants to 82 teachers from eight countries (cf. Figure 2). The 82 teachers were contacted via internal mail on the virtual platform for the master's degree to answer the questionnaire described in the following section.
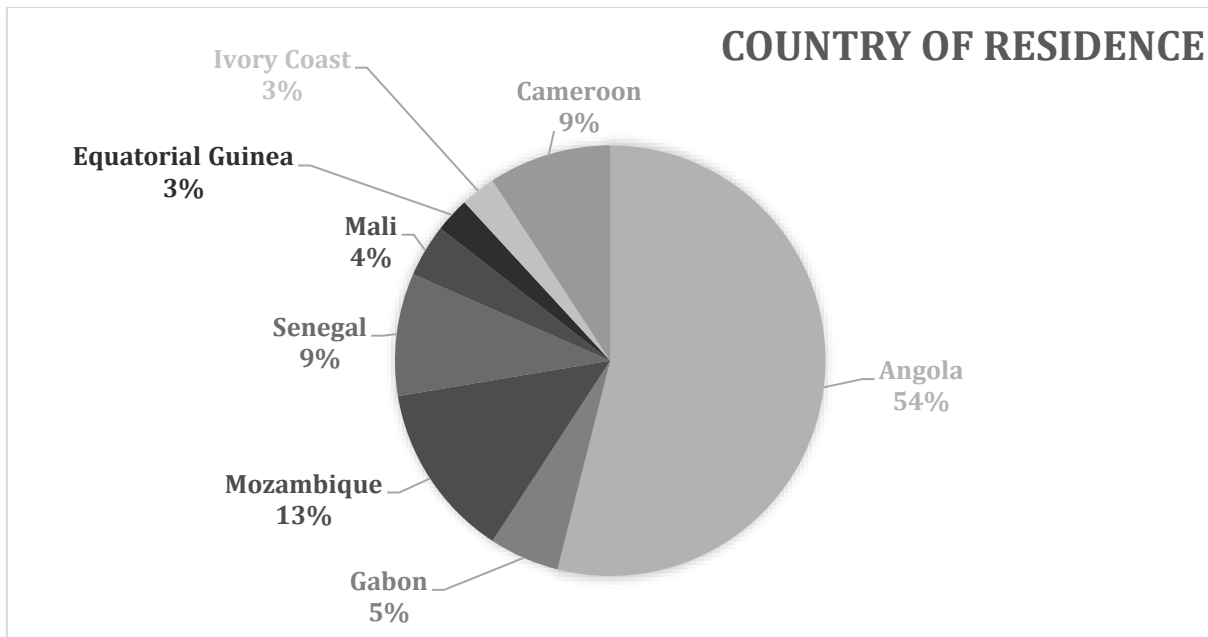
COUNTRY OF RESIDENCE

Ivory Coast
3%

Cameroon
9%

Equatorial Guinea
3%

Mali
4%

Senegal
9%

Angola
54%

Mozambique
13%

Gabon
5%

Figure 2 Participants' countries of residence

Data Collection
A questionnaire was used to collect data on the graduate teachers' perceptions of their digital competence. The questionnaire was constructed with closed and open-ended questions covering three dimensions (curriculum and assessment, pedagogy, and application of digital competences). The first section of the questionnaire includes a series of closed questions on a Likert scale with five possible answers (related to the dimensions proposed by the UNESCO ICT competency framework (2019) at three levels: acquisition, deepening and creation) followed by a series of semi-open questions related to the competences (cf. Figure 3).
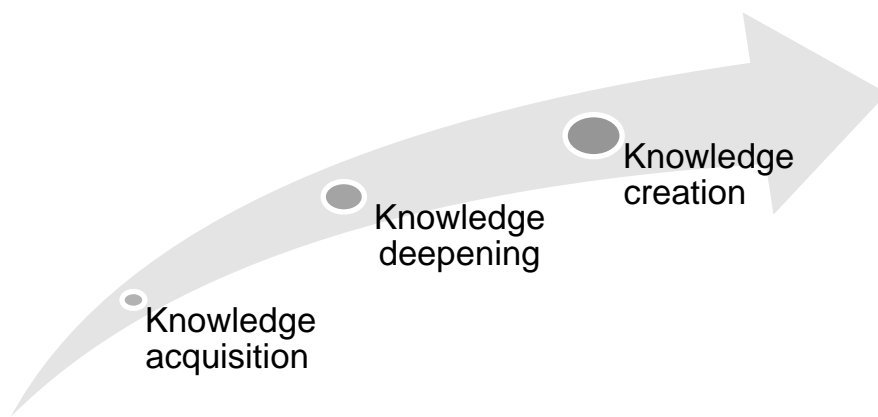
Knowledge
creation

Knowledge
deepening

Knowledge
acquisition

Figure 3 Elaboration based on competency levels (*ICT Competency Framework for Teachers* (UNESCO, 2019))

The second section of the questionnaire includes a series of open-ended questions to delve deeper into aspects related to the competency areas covered by the closed questions (qualitative data). The questionnaire was reviewed and validated by two experts in educational technology who used an evaluation rubric that enabled endorsing the questionnaire according to its validity of content, location, and intelligibility. After the review, the questionnaire was finally applied individually and in an online format to the sample of 82 teachers (cf. Table 2) in March to April of the 2019–2020 academic year.

Data Analysis
The analysis was done with the use of version 15 of the SPSS software for Windows to allow the identification and grouping of the quantitative data from the closed questions on the Likert scale. The digital coding and statistical descriptive processing

were extracted from this program to categorise the information according to the requirements of the collected data as identified with the research objectives.

For the qualitative analysis of the open questions, a coding system related to the study categories was developed (Bardin, 1970). Version 8.0 of the ATLAS.ti program was used for the systematic analysis of the transcripts and the grouping of the comments to identify themes and to subsequently establish the conclusions of the study (cf. Table 1).

Table 1 Analysis categories

Categories	Codification
Curriculum and assessment	CA
Pedagogy	PE
Application of digital competences	AD

Findings and Discussion

The teachers' perceptions of their digital competence were evaluated based on the three dimensions. Each category was also further divided into three levels of competency complexity (cf. Table 2).

The results are first presented according to the levels of competence.

Table 2 Reported competence acquired by teaching

Categories x Competency levels	CA	PE	AD
Knowledge acquisition	37.3%	28.4%	12.8%
Knowledge deepening	41.2%	34.3%	34.3%
Knowledge creation	21.5%	37.3%	52.9%

For the qualitative analysis, testimonies of the participants have been included. In each testimony the code of the category of analysis is indicated according to the topic addressed (CA, PE, AD) and also the code assigned to each participant subject (1, 2, 3, 4...).

Curriculum and Assessment

The CA dimension includes how ICTs may facilitate the achievement of curriculum objectives and how it may facilitate assessment. Concerning the first level, the document refers to the recognition of the benefits of applying ICT within educational processes. The second level refers to the application of ICT for the purpose of deepening of knowledge. The third and final level of creation would require teachers' ability to reflect on the curriculum and the integration of ICT, as well as develop "authentic assessment strategies to monitor progress" (UNESCO, 2019:23).

The quantitative analysis shows that a high percentage of the sample (78.5%) recognised the advantages of working with ICTs and promoting the tools in the acquisition of knowledge in their teaching processes. In addition, they confirmed the potential of ICTs in the promotion of motivation, the construction of students' knowledge and as a tool for educational change (Pariente Alonso, 2005).

> ICT makes the work easier, especially concerning the abundance of sources for research and consultation. Some tools awaken students' curiosity and stimulate creation (CA, 4).
> It certainly favours a better use of the available tools. Students are more interested in content when I include something related to technology. It promotes more challenges for them and also for us, the educators. I would say that the integration of ICT also facilitates the use of active methodologies. (CA, 28)

Du Plessis (2020) states that the inclusion of ICTs is intended to respond to the demands of the new society and that to do so, it is necessary to improve teaching. This is evident in the level of knowledge creation category, where only 21% of teachers reported feeling capable of creating knowledge:

> Create? No. But I feel perfectly capable of adapting a resource according to the circumstances of my students. For example, I ask them to Google the aspects that are important for the class, that is, I guide them so that they do not waste time in their search of so much available information. (CA, 41)

The deeper level of competence required for content creation to respond to the needs of modern day students, as asserted by Figueroa Millán (2000), was not found and there were no specific examples in any of the teachers' explanations. It was also not a confirmed perception in their accounts of their teaching practice.

Pedagogy

The pedagogical aspect refers to the acquisition of competence for the improvement of teaching-learning methods. It is a dimension exclusively related to the teacher's work and the conditions they believed to possess to improve their professional practice. In the first level of acquisition, we sought to understand whether ICT was integrated into traditional teaching methods. The second and third levels required the teachers to adopt alternative pedagogies that sought to provide students with

greater protagonism and autonomy. The levels of deepening and creation integrate ICTs within a cooperative and collaborative conception of work with methodologies such as problem-based and/or project-based learning.

In this dimension, 28.4% of the sample claimed to possess only the first level of knowledge (acquisition). "*Lately, I already feel fully capable of properly selecting the technologies that can help with certain aspects of learning*" (PE, 45).

Some teachers who were of the opinion that they only possessed the first level of competence in the use of ICT highlighted the difficulties that they experienced regarding the involvement of their students and reflected the assumptions of Coll et al. (2007) on the practice of recreating different educational experiences through technology to involve the students.

> *I use technology so that students can study at home and improve their performance because they are increasingly interested and drawn to digital tools. It's not something we can ignore. But I think they do not use them for educational purposes. Because of this, I need to always propose mediations and activities that can be evaluated, so that they become interested and use technology to improve their learning.* (PE, 21)

As previously stated in Pozo's (2017:7) commentary, "being a native in technology is not the same as being an immigrant in it", the findings of our study are related to the need for a change of mentality that requires the application of ICT in the classroom, taking into account that students master at using ICTs.

Some teachers reported that they thought that they were capable of deepening and creating in the teaching-learning processes.

> *I feel that I can propose things, but that students are not interested in using technology for learning. This scares me a little because it's as if they don't see me capable of teaching them anything with a tool that they feel is theirs, but not that of a teacher older than them.* (PE, 13)

At the level of knowledge creation, where 37.3% of teachers considered themselves capable of putting these actions into practice, we only found one quote that reflected on this action.

> *This is not yet the beginning of the process. I need to use more, but it is true that since I started working with collaborative activities with the support of the internet, students are more involved. I think I will continue with this strategy so that students can study at home too.* (PE, 7)

This case also confirms the need to offer training for teachers to enable them to cope with current educational demands (Du Plessis, 2020) which include the creation and transformation of content.

Application of Digital Competence
This aspect is related to the application of core competence for the implementation of Information Technology (IT). UNESCO (2019) states that teachers cannot identify and integrate pedagogical tools into their teaching-learning processes without the acquisition of digital teaching competence. The levels of deepening and creation are more related to actions of analysis, security, and the capacity to create learning communities that favour and improve learning. To this end, this competence dimension evaluated both the teachers' perceptions of their level of development and the challenges and educational needs they considered possessing.

Teachers mentioned being able to identify ICT tools that can best be applied in the teaching-learning processes. Although the sample was created after a first validation on the basic knowledge of the competences in the ICT framework, it was discovered that despite the teachers considering to have competence in the last level of knowledge creation over the three aspects (CA: 21.6%, PE: 37.3%, AD:52.9%), their stories related more to the deliberate application of technology than to creation itself.

> *Yes, a Facebook group was created with my students' parents to exchange topics about the contents we are working on. It is not an ideal process, but it is a start. The children work at home with their parents and we then see what each one contributes to class.* (AD, 14)

This confirms that it is necessary to deepen the role of the teacher, so that he/she is able to promote the interaction of information based on the analysis and selection of resources appropriate to his/her teaching context (Rangel, 2015). In addition, relating to their perceptions of what they could do with ICT, teachers addressed the difficulties and challenges encountered in their work. Teachers also highlighted the lack of information and/or awareness of families regarding the application of technology.

> *The most difficult thing is to convince my director that this is not a fad but a process that could be applied in the whole school, as a new philosophy, as they do in other more developed countries. But I feel a lot of resistance and that discourages me.* (AD, 37)
>
> *The point is that children learn quickly, and they like it, but I don't feel that families support this integration. It's something like ... it's your job; I don't have time for that stuff at home* (AD, 12).

Another element mentioned by teachers was the need for educational institutions to get involved, especially concerning technological resources, considering the socio-economic deficiencies of the context in which they worked.

> *I think that integration is good as long as we find the infrastructure to use it. Many of my students here at XXX, do not have mobile phones; it is an illusion to want to work with this kind of resource.* (AD, 40)
>
> *I do read and take an interest in the subject, but my work environment does not have the infrastructure. The kids come to school for a snack ... do you think that if we don't give them all the resources, the technology will be relevant? No, we are at an earlier*

stage. This should be a government project and not just one overseen by teachers. (AD, 8).

Before thinking about the pedagogical part and the training of teachers, it would be necessary to have the support of private institutions, because the government cannot solve everything alone. Not all students have mobile phones, let alone tablets or computers. Without the required devices, training for this is useless. (AD, 29)

In this regard, teachers indicated that they felt isolated in their intention to be trained and to apply technology in schools.

It's that we study that ICT is fundamental, OK. But then, when you propose to apply and create a project or something more collaborative, nothing happens, everyone keeps working the same. So you don't see any sense in continuing to improve, because it is something that is not valued, you know? (AD, 25)

In this sense, what Rangel (2015) states about the need for the teacher to assume his/her role in the field of ICT competence in an investigative and collaborative way is not enough for the success of the process. If teachers feel isolated and undervalued in their attempts towards change through ICT, this involvement may be compromised by external factors, such as the lack of institutional support and from other teachers at the school.

Another aspect highlighted by the teachers was the lack of information and/or sensitisation of families regarding the application of technology.

The thing is that the children learn fast and they like it, but I don't feel that the families support this integration. It's something like ... it's your job, I don't have time for those things at home (CD, 12).

With respect to the development of the peripheral competences related to techniques and didactics that they mention (Engen, 2019; Vera, Torres & Martínez, 2014) these will appear together with the technological competence in the question on the formative needs related to this competence dimension.

This relationship could be seen in the question on training needs, in which the teachers considered it particularly relevant to learn how to mediate knowledge and tools, as well as being able to create activities with a specific pedagogical purpose (cf. Figure 4).
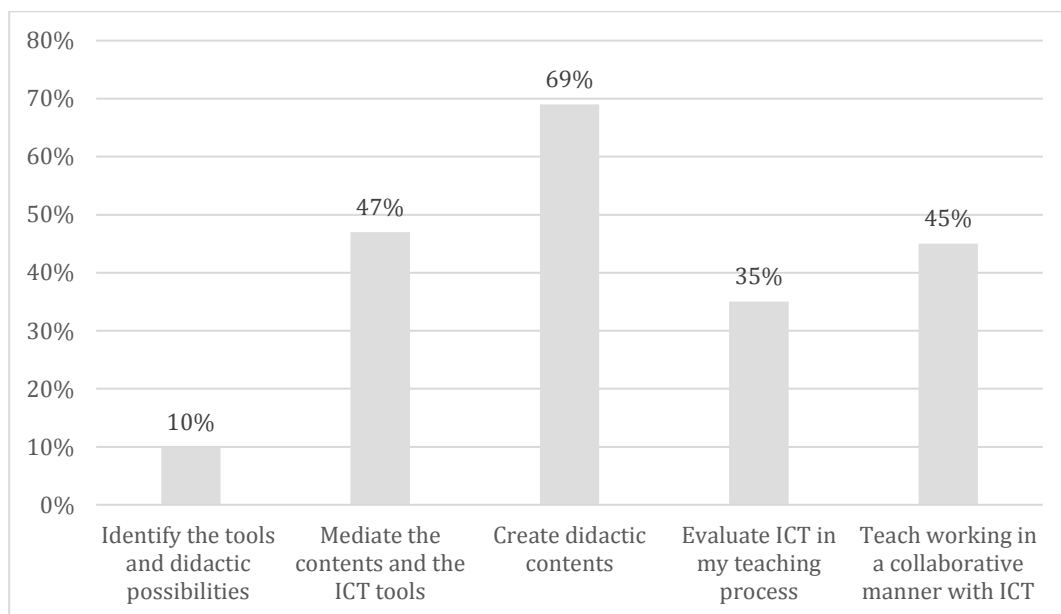

Figure 4 Training needs related to the application of digital teaching competence

Conclusion

The purpose of this research was to analyse the perceptions of primary school teachers from eight African countries about their digital competence in the areas of CA, PE and AD, aspects defined in UNESCO's (2019) digital competences framework. The results show a positive view on the acquired competence, with some difficulties in the participants' work contexts that can be a hindrance in the development of other competences.

In the first place, teachers recognised that the use of technology was an aspect to be taken into account in elementary school classes since most of the students knew and used technology in daily tasks, even outside of their studies. The participants' general perceptions were that they possessed ICT teaching competences in the three areas, CA, PE and AD, especially at the level of acquisition and deepening of knowledge.

The most advanced competency level, knowledge creation, was mentioned less by the participating teachers. In addition, a conceptual confusion was detected about what it was to apply technology and what it was to be able to innovate with the use of technology, since no evidence had

been found that reflected the creation of knowledge based on technology.

What came to the fore were the challenges encountered by teachers in the use of ICT in their elementary classrooms, ranging from a lack of support from the school's management body and families, a lack of technological resources to the students' lack of interest.

With this study we revealed the need to promote theoretical and practical training in the field of ICT-based content creation for primary education. We have also revealed important related needs for the application of technology to be effective, such as the support of institutions, the awareness of families and access to technology in the centres.

Recommendations

It is recommended that teacher training in digital competence be prepared with an instructional design that promotes contact with real teaching-learning situations based on innovation in order to solve the conceptual confusion that teachers have about what it is to create and what it is to apply.

We also suggest that, in this design, complementary areas to the creation of content should be contemplated, for example, communication strategies and sensitisation of families on the use of ICT and strategies for adapting their use in the case of the lack of resources at educational centres. The lack of institutional support regarding the application of ICT in primary classrooms experienced by some of the teachers could possibly be minimised by training school management on the effective use of ICT.

Future studies could analyse the progress of digital teaching competence in the area of creation, based on face-to-face and/or distance training with the teachers who participated in this research. The results of an integrated sensitisation between managers and families of primary school students regarding the use of ICT could also be analysed.

Finally, it is recommended that international, national and local policies to overcome the lack of technological resources in primary schools should be developed. Difficulties regarding access to technology constitute a major barrier to comply with the *ICT Competency Framework for Teachers* as a tool to boost initial and continuous teacher training in the use of ICT (UNESCO, 2019).

Authors' Contributions

Conceptualisation and methodology: Oscar Ulloa-Guerra, Andresa Sartor-Harada, and Juliana Azevedo-Gomes. Software, validation, and formal analysis: Andresa Sartor-Harada, Oscar Ulloa-Guerra, Juliana Azevedo-Gomes, Roberto Ruiz and Rubén Calderón. Project administration and funding acquisition: Andresa Sartor-Harada, Juliana Azevedo-Gomes, Roberto Ruiz and Rubén Calderón. Investigation, preparation for and writing the original draft: Andresa Sartor-Harada, Oscar Ulloa-Guerra, and Juliana Azevedo-Gomes. Writing, review and editing: Andresa Sartor-Harada and Oscar Ulloa-Guerra. All authors read and agreed to the final version of the manuscript.

References

Aguaded JI & Cabero J (eds.) 2013. *Tecnologías y medios para la educación en la e-sociedad* [Technologies and media for education in the e-society]. Madrid, Spain: Alianza Editorial.

Area Moreira M 2008. La innovación pedagógica con TIC y el desarrollo de las competencias informacionales y digitales. *Investigación en la Escuela*, 64:5–17. Available at https://idus.us.es/bitstream/handle/11441/60859/R64_1.pdf. Accessed 31 August 2022.

Asenjo Gómez JT & Asenjo Gómez F 2021. La autopercepción de la competencia digital en los docentes: Variaciones tras el confinamiento [Self-perception of digital competence in teachers: Variations after confinement]. *Revista Española De Educación Comparada*, 38:174–189. https://doi.org/10.5944/reec.38.2021.29032

Azinian H 2009. *Las tecnologías de la información y la comunicación en las prácticas pedagógicas* [Information and communication technologies in pedagogical practices]. Buenos Aires, Argentina: Noveduc Libros.

Bardin L 1970. *El análisis de contenido* [Content analysis]. Madrid, Spain: Akal.

Betancourt-Odio MA, Sartor-Harada A, Ulloa-Guerra O & Azevedo-Gomes J 2021. Self-perceptions on digital competences for m-learning and education sustainability: A study with teachers from different countries. *Sustainability*, 13:343. https://doi.org/10.3390/su13010343

Buckworth J 2017. Issues in the teaching practicum. In G Geng, P Smith & P Black (eds). *The challenge of teaching: Through the eyes of pre-service teachers*. Singapore: Springer. https://doi.org/10.1007/978-981-10-2571-6

Cacheiro González ML 2018. *Educación y tecnología: Estrategias didácticas para la integración de las TIC* [Education and technology: Didactic strategies for the integration of ICT]. Madrid, Spain: UNED.

Carrera FX & Coiduras JL 2012. Identificación de la competencia digital del profesor universitario: Un estudio exploratorio en el ámbito de las Ciencias Sociales [Identifying the digital competence of university lecturers: An exploratory study in the field of Social Science]. *Revista de Docencia Universitaria*, 10(2):273–298. https://doi.org/10.4995/redu.2012.6108

Coll C 2008. Aprender y enseñar con las TIC: Expectativas, realidad y potencialidades [Learning and teaching with ICT: Expectations, reality and potential]. *Boletín de la Institución Libre de Enseñanza*, 72:17–40.

Coll C & Monereo C 2008. Educación y aprendizaje en el siglo XXI: Nuevas herramientas, nuevos escenarios, nuevas finalidades [Education and learning in the 21st century: New tools, new scenarios, new purposes]. In C Coll & C Monereo (eds). *Psicología de la educación virtual: Aprender y enseñar con las tecnologías de la información y la comunicación* [Psychology of virtual education: Learning and teaching with information and communication technologies]. Madrid, Spain: Morata.

Coll C, Onrubia J & Mauri T 2007. Tecnología y prácticas pedagógicas: Las TIC como instrumentos de mediación de la actividad conjunta de profesores y estudiantes. *Anuario de Psicología*, 38(3):377–400. Available at https://raco.cat/index.php/AnuarioPsicologia/article/view/76571/98224. Accessed 31 August 2022.

Domínguez HJA, Bárcenas LJ, Ruiz-Velasco S & Tolosa SJ 2014. *Hacia las competencias digitales en la actividad docente: Un diagnóstico para definir los elementos fundamentals* [Towards digital competences in teaching activity: A diagnosis to define the fundamental elements]. Paper presented at the XV Virtual Educa International Symposium, Lima, Peru, 9–13 June.

Du Plessis E 2020. Student teachers' perceptions, experiences, and challenges regarding learner-centred teaching. *South African Journal of Education*, 40(1):Art. #1631, 10 pages. https://doi.org/10.15700/saje.v40n1a1631

Engen B 2019. Comprendiendo los aspectos culturales y sociales de las competencias digitales docents [Understanding social and cultural aspects of teachers' digital competencies]. *Comunicar,* 61:9–19. https://doi.org/10.3916/C61-2019-01

Esteve-Mon FM, Llopis-Nebot MÁ & Adell-Segura J 2020. Digital teaching competence of university teachers: A systematic review of the literature. *IEEE Revista Iberoamericana de Tecnologías del Aprendizaje*, 15(4):399–406. https://doi.org/10.1109/RITA.2020.3033225

Fernández-Batanero JM, Montenegro-Rueda M, Fernández-Cerero J & García-Martínez I 2022. Digital competences for teacher professional development. Systematic review. *European Journal of Teacher Education*, 45(4):513–531. https://doi.org/10.1080/02619768.2020.1827389

Fernández-Cruz F & Fernández-Diaz M 2016. Los docentes de la Generación Z y sus competencias digitales [Generation Z's teachers and their digital skills]. *Comunicar*, 46:97–105. https://doi.org/10.3916/C46-2016-10

Figueroa Millán LM 2000. La formación de docentes en las escuelas normales: Entre las exigencias de la modernidad y las influencias de la tradición [Teacher training in normal schools: Between the demands of modernity and the influences of tradition]. *Revista Latinoamericana de Estudios Educativos*, XXX(1):117–142. Available at https://www.redalyc.org/articulo.oa?id=27030105. Accessed 14 May 2020.

Garzón-Artacho E, Sola-Martínez T, Romero-Rodríguez JM & Gomez-García G 2021. Teachers' perceptions of digital competence at the lifelong learning stage. *Heliyon*, 7(7):e07513. https://doi.org/10.1016/j.heliyon.2021.e07513

González Rey F 1997. *Epistemología cualitativa y subjetividad* [Qualitative epistemology and subjectivity]. La Habana, Cuba: Pueblo y Educación.

Hakkarainen K, Ilomäki L, Lipponen L, Muukkonen H, Rahikainen M, Tuominen T, Lakkala M & Lehtinen E 2000. Students' skills and practices of using ICT: Results of a national assessment in Finland. *Computers & Education*, 34(2):103–117. https://doi.org/10.1016/S0360-1315(00)00007-5

Hall R, Atkins L & Fraser J 2014. Defining a self-evaluation digital literacy framework for secondary educators: The DigiLit Leicester project. *Research in Learning Technology*, 22:1–17. https://doi.org/10.3402/rlt.v22.21440

Jiménez K, Miguel V, Fernández M & Díaz K 2017. Percepción de competencias digitales en docentes universitarios en formación [Digital competence perception in university instructors under training]. *Revista Proyección*:81–89. Available at http://www.sirius.une.edu.ve/recursos/blogs/cdcht/wp-content/uploads/2018/03/Revista-Proyecci%C3%B3n-Edici%C3%B3n-Especial-JITS-2017.pdf. Accessed 10 June 2020.

Jung I 2005. ICT-pedagogy integration in teacher training: Application cases worldwide. *Educational Technology & Society*, 8(2):94–101.

Karatepe R & Akay C 2020. The study of the relationship between 21st-century learner skills, individual innovativeness and epistemological beliefs of teacher candidates by structural equation modelling. *South African Journal of Education*, 40(Suppl. 2):Art. #1795, 15 pages. https://doi.org/10.15700/saje.v40ns2a1795

Kaushik V & Walsh CA 2019. Pragmatism as a research paradigm and its implications for social work research. *Social Sciences*, 8(9):255. https://doi.org/10.3390/socsci8090255

Mateo J 2004. La investigación ex post-facto [Ex post facto research]. In R Bisquerra (ed). *Metodología de la investigación educative* [Metodología de la investigación educative]. Madrid, Spain: La Muralla.

Moodley K, Callaghan P, Fraser WJ & Graham MA 2020. Factors enhancing mobile technology acceptance: A case study of 15 teachers in a Pretoria secondary school. *South African Journal of Education*, 40(Suppl. 2):Art. #1791, 16 pages. https://doi.org/10.15700/saje.v40ns2a1791

Morales M, Trujillo JM & Raso F 2015. Percepciones acerca de la integración de las TIC en el proceso de enseñanza-aprendizaje de la Universidad [Perceptions about ICT's integration in the teaching-learning process in the university]. *Píxel-Bit. Revista de Medios y Educación*, 46:103–117. https://doi.org/10.12795/pixelbit.2015.i46.07

Núñez C, Gaviria-Serrano JM, Tobón S, Guzmán-Calderón CE & Herrera SR 2019. La práctica docente mediada por TIC: Una construcción de significados [Teaching practice mediated by ICT: A significance construction]. *Revista Espacios*, 40(5). Available at https://revistaespacios.com/a19v40n05/19400504.h

tml. Accessed 14 May 2020.

Pariente Alonso FJ 2005. Hacia una auténtica integración curricular de las tecnologías de la información y comunicación [Towards an authentic curricular integration of information and communication technologies]. *Revista Iberoamericana de Educación*, 36(10):1–6. https://doi.org/10.35362/rie36102757

Perifanou M, Economides AA & Tzafilkou K 2021. Teachers' digital skills readiness during COVID-19 pandemic. *International Journal of Emerging Technologies in Learning*, 16(08):238–251. https://doi.org/10.3991/ijet.v16i08.21011

Pozo JI 2017. El cambio de las concepciones docentes como factor de la revolución educative [The change of teaching conceptions as a factor of the educational revolution]. *Revista Q*, 3(5):1–27. Available at https://search.proquest.com/openview/1cbb699761 5baf495ff509af26df70b7/1?pq-origsite=gscholar&cbl=1666340. Accessed 10 May 2020.

Quiñonez Pech SH 2020. Competencia digital de los profesores de inglés en enseñanza primaria del sureste de México [Digital competence of elementary school English teachers in Southeast Mexico]. *Revista Iberoamericana para la Investigación y el Desarrollo Educativo*, 11(21):e132. https://doi.org/10.23913/ride.v11i21.752

Rangel A 2015. Competencias docentes digitales: Propuesta de un perfil [Digital teaching skills: A profile]. Píxel-Bit. *Revista de Medios y Educación*, 46:235–248. https://doi.org/10.12795/pixelbit.2015.i46.15

Robles Amavizca KL & Ángulo Armienta J 2018. Percepción sobre competencias digitales docentes en profesores universitarios [Perception on digital teaching competences in university professors]. *Educación y Ciencia*, 6(49):7–13. Available at http://www.educacionyciencia.org/index.php/educa cionyciencia/article/view/430/pdf_35. Accessed 15 May 2020.

Rusznyak L 2018. What messages about teacher professionalism are transmitted through South African pre-service teacher education programmes? *South African Journal of Education*, 38(3):Art. #1503, 11 pages. https://doi.org/10.15700/saje.v38n3a1503

Santos Rego MA, Jover Olmeda G, Naval C, Álvarez Castillo JL, Vázquez Verdera V & Sotelino Losada A 2017. Diseño y validación de un cuestionario sobre práctica docente y actitud del profesorado universitario hacia la innovación (CUPAIN) [Design and validation of a questionnaire on university teaching practice and attitude towards innovation (CUPAIN)]. *Educación XXI*, 20(2):39–71. https://doi.org/10.5944/educxx1.19031

Sartor-Harada A 2018. El portafolio como herramienta de desarrollo del aprendizaje reflexivo en los entornos virtuales [The portfolio as a tool for the development of reflexive learning in virtual environments]. *Santiago*:253–268. Available at https://santiago.uo.edu.cu/index.php/stgo/article/vi ew/4837/4201. Accessed 31 August 2022.

Serafín Diel N & Bueno Pérez LA 2019. Sistematización de experiencias educativas como alternativa de optimización de procesos formativos en países del África Subsahariana [Systematization of educational experiences as an alternative for the optimization of education in countries of Sub-Saharan Africa]. *Transformación*, 15(1):85–96. Available at http://scielo.sld.cu/scielo.php?script=sci_arttext&pi d=S2077-29552019000100085. Accessed 10 June 2020.

Suárez Rodríguez JM, Almerich G, Gargallo Lópe B & Aliaga FM 2013. Las competencias del profesor en TIC: Estructura básica [The competencies of teachers in ICT: Basic structure]. *Educación XX1*, 16(1):39–62. https://doi.org/10.5944/educxx1.16.1.716

Tejada Fernández J 2009. Competencias docents [Teachers competencies]. *Profesorado. Revista de Currículum y Formación del Profesorado*, 13(2):1–15. Available at https://www.redalyc.org/articulo.oa?id=567117980 15. Accessed 10 June 2020.

Tejada Fernández J & Pozos Pérez KV 2018. Nuevos escenarios y competencias digitales docentes: Hacia la profesionalización docente con TIC [New scenarios and trainers' digital competencies: Towards the professionalization of teaching with ICT]. *Profesorado. Revista de Currículum y Formación del Profesorado*, 22(1):25–51. Available at https://digibug.ugr.es/handle/10481/52320 Accessed 15 May 2020.

United Nations Educational, Scientific and Cultural Organization 2019. *UNESCO's ICT competency framework for teachers*. Available at https://www.unesco.org/en/digital-competencies-skills/ict-cft#:~:text=The%20ICT%20Competency%20Fram ework%20for,K%2D12%20to%20tertiary%20level . Accessed 10 June 2020.

Usher EL & Pajares F 2008. Self-efficacy for self-regulated learning: A validation study. *Educational and Psychological Measurement*, 68(3):443–463. https://doi.org/10.1177/0013164407308475

Vera JA, Torres LE & Martínez EE 2014. Evaluación de competencias básicas en TIC en docentes de educación superior en México [Assessment of basic ICT competencies in teachers of higher education in Mexico]. *Pixel-Bit. Revista de Medios y Educación*, 44:143–155. https://doi.org/10.12795/pixelbit.2014.i44.10